

ASSESSING THE RELATIONSHIP BETWEEN IQ SCORES AND THE  
RATE OF ACQUISITION AND RETENTION OF A  
SIMPLE LEARNING TASK

An abstract of a Thesis by  
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The problem. The concept of intelligence has never been precisely defined, yet standardized intelligence tests frequently are employed in the public school system to predict academic performance and to place students accordingly. The underlying assumption seems to be that IQ scores measure intelligence and that intelligence affects learning, or that intelligence somehow is the ability to learn. This study will measure the performance of elementary school students in a standardized operant discrimination task and assess the relationship of their IQ scores to such performance measures.

Procedure. Five first-grade students, each with differing IQ classifications, were given a novel labeling task. This consisted of a one-to-one instructional period followed by a session post-test to assess the number of labels learned during the session. Token reinforcement was administered for each correct response during the post-tests. A comparison was made between the number of trials to mastery of the task and IQ level. The subjects were re-tested after a three-month time lapse to determine how much of the learning was retained.

Findings. The results indicated that there was a slight positive relationship between IQ level and rate of acquisition. However, a detailed analysis of each child's performance revealed differing patterns of learning which should not be disregarded. There was no correlation between IQ level and retention.

Conclusions. The relationship between IQ and learning is not as straightforward as might be assumed. Thus, caution should be exercised regarding its sole use as a predictor of academic success.

Recommendations. Further research on this issue incorporating a larger sample of subjects and more sensitive measures of learning is suggested in an attempt to provide more illuminating information.

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## Chapter 1

### REVIEW OF LITERATURE

"Intelligence" is a term that is commonly used to account for some of the individual differences among members of our society. Traditionally, intelligence is characterized as "the capacity to acquire and apply knowledge" (American Heritage Dictionary, 1969). Some regard such a capacity as an "endowment" (Brown & Herrnstein, 1975); others view it as a set of specifiable behavioral skills (Staats, 1971); and others are concerned only with the operational definition thereof, e.g., intelligence is what intelligence tests measure (Lazerson, 1975). Nevertheless, history has demonstrated that the view held concerning the nature of intelligence is extremely important in determining political and social actions (Kamin, 1974; Staats, 1971).

Underlying these definitions of intelligence is a heated controversy concerning "its" origin. Researchers can be divided into two relatively distinct perspectives on this issue: the geneticists, who maintain that intelligence is primarily a biologically inherited trait (Brown & Herrnstein, 1975), and the environmentalists, who view intelligence as an explanatory construct reflecting what has been learned (Staats, 1971).

The relationship of intelligence, regardless of its origin in genes or experience, to the IQ score which

presumably is its quantitative measure, is itself another confusing and long debated issue. For example, the assumption that the IQ test accurately and comprehensively measures intelligence can be challenged on at least three grounds. First, it seems unlikely that one could obtain an adequate measure of intelligence when operating in the absence of a common definition. Second, the content validity of intelligence tests can be questioned if the test items are selected according to what information the test constructors consider important (Brown & Herrnstein, 1975; Staats, 1971). Finally, certain methodological problems involved in the use of standardized testing conditions (such as only one "right" answer) cast doubt upon the accuracy and sensitivity of the instrument (Zacharis, 1975).

In spite of criticism of the intelligence test, it has received both prestige and widespread use for a variety of purposes in the last several decades. There is a long history of use, primarily by the public schools to predict academic performance in students for the purpose of curricular placement (Kolstoe, 1967). The apparent success of the predictive value of such testing may be due simply to the empirical selection of specific items based upon their correlation with school success (Staats, 1971). However, it is well understood that there are additional variables that confound the directness of such a predictive relationship. Some factors bear on the accuracy of the IQ score as a

measure of some presumed underlying capacity, while others directly affect school performance as the predicted outcome. As an example of the first, Ayllon and Kelly (1972) significantly increased performance on a standardized intelligence test by the use of explicit reinforcement for correct answers. This has been interpreted as substantiating the effect of motivation on IQ test performance (O'Connor & Weiss, 1974) .

Additionally, several variables are known to affect school performance. For example, Cobb (1972) found that academic achievement was highly correlated with the presence of observable work skills such as attending to task and compliance with the teachers' directions, behaviors which themselves are not often thought to necessarily reflect intelligence. Probably more troublesome in terms of its implications for academic prediction based upon IQ scores is the situation which often results when a student with a low IQ is placed out of the "mainstream" in a group with others having similar scores. In such a setting, usually called Special Education, students are characteristically given less challenging academic tasks, obviously resulting in less academic accomplishment, and the low accomplishment prediction becomes fulfilled as the direct consequence of the special placement.

Because of these and other complicating variables, the validity of this suggested relationship needs to be



investigated in a more straightforward manner than by simply correlating IQ with school performance. Simpler measures of learning are called for. For example, the paradigm used to investigate the acquisition and the retention of a discriminated operant is a well-understood basic research method providing such a simple measure, and one which also bears an obvious relationship to traditional academic performance (Skinner, 1953, 1968).

This study measures the performance of elementary school students in a standardized operant discrimination task to empirically assess the relationship of their IQ scores to such performance measures. The rates of acquisition and retention for children with widely discrepant IQ scores will either lend support to or argue against the traditional practice of predicting achievement from an IQ score for the purpose of educational tracking, at least insofar as school achievement depends upon such elementary learning skills.

## Chapter 2

### METHOD

#### Subjects

All but one of the five subjects were selected from a class of students at East Elementary School in Norwalk, Iowa. The other was a student at one of the inner city schools in Des Moines, Iowa. These general criteria for selection were adhered to:

1. All subjects were approximately the same chronological age, 7 to 8 years old.
2. All subjects were given an intelligence test by a school psychologist within the past year.
3. The IQ scores received on the tests were distributed such that at least one student fell in each of the following ranges:

Gifted	130 and above	2 S.D.'s above the mean
Average	90-109	
Borderline mentally retarded	70-79	2 S.D.'s below the mean

Precise information is provided in Table 1.

#### Token Training Procedure

Generally, the optimum dependent variable would be a simple measure of the rate of acquisition and retention containing few, if any, confounding factors. Not all

Table 1

Information compiled for the intelligence classification of each subject.

Subject			Age	Test	IQ		Classification
1*	(M)	7 years, 2 months		WISC	Verbal	139	Gifted
					Performance	149	
					Full Scale	147	
2	(F)	7 years, 9 months		Slosson		127	Above Average
3	(M)	7 years, 6 months		WISC	Verbal	109	Average
					Performance	103	
					Full Scale	107	
4	(F)	8 years, 2 months		WISC	Verbal	79	Borderline Mentally Retarded
					Performance	97	
					Full Scale	86	
5	(F)	7 years, 6 months		Stanford Binet		78	Educable Mentally Retarded

\*This subject was not a student at the same school as the other subjects and the intelligence test was administered by the author.

children are equally motivated by social reinforcement such as feedback from an adult regarding the correctness of a response. To best follow the operant model, it was decided to provide extrinsic reinforcement that was demonstrably effective for each child. Tokens, in combination with a selection of back-up reinforcers, should maximize the effectiveness of the reinforcement to each individual child. Sessions were therefore conducted prior to the introduction of the actual learning task to establish the effectiveness of a token system, and to familiarize the subjects with the exchange value of tokens.

The materials used to establish tokens as reinforcers were three different puzzles of similar difficulty (ages 3-6), poker chips, and back-up reinforcers which consisted of a variety of candies and small plastic toys. On the first day, the puzzles were displayed on a table with a chair placed in front of each puzzle. The child was asked to select and put together the puzzle of his choice. During this time, the child received attention and feedback from the experimenter concerning the correctness of his efforts. When the subject finished with his first choice puzzle, the experimenter then selected a different puzzle and requested that the child also put it together. For each piece correctly placed, the child received both social and token reinforcement at the rate of one poker chip per correct placement. When the child finished putting the puzzle together,

he or she was promptly allowed to exchange the tokens earned for the back-up reinforcers. During each succeeding session, the subject was asked to select any puzzle that he wanted, but only received tokens for working the previously reinforced puzzle. This procedure continued until each subject reliably selected the "token-puzzle" as the first choice, thus indicating that the tokens had acquired a generalized reinforcing property.

#### Pre-test

The purpose of the pre-test was to assess the subjects' knowledge of the names of various types of birds. During individual sessions, each child was seated across from the experimenter, and asked to name different birds, each pictured separately on a total of 30 flashcards. Correct, incorrect, or an approximation to a correct response was recorded by the experimenter following each response. For each picture named correctly, the subject earned a token. The purpose of presenting token reinforcement during the pre-test was to insure that such a motivational factor remained constant and thus did not confound the rates of learning observed during the instruction phase of this experiment.

After all subjects were given the pre-test, a set of 15 flashcards was selected, each card of which was unknown to all of the subjects, to serve as the stimulus materials for the next phase of the experiment.

### Instruction and Post-test

The group of unknown picture flashcards was divided into three groups of 5 cards each, groups A, B, and C. The same instructional procedure was conducted for each card within all groups of 5 cards. The experimenter stated the name of the bird, asked the subject to repeat the name of the bird, described two distinguishing features of the bird, and finally again asked the subject to name the bird. During this sequence, the subjects received feedback concerning the correctness of the responses; however, no token reinforcement was given. If the last response was answered correctly without aid from the experimenter, then she proceeded in the same fashion to teach the name of the bird on the next flashcard within the group of 5 cards. During each session, the picture flashcards were presented in random order. In order to insure that the pacing of the session was largely controlled by the subject, the experimenter waited until she had eye contact with the subject before continuing with the learning task.

When the subject responded correctly to all 5 flashcards within the group, then a session post-test was administered. The session post-test stimuli consisted of 8 picture flashcards; the 5 in the particular group being learned, and 3 picture cards that the subject already knew, as determined by the pre-test. These 3 cards were consistently used during all subsequent post-tests. During the

post-test, the experimenter simply asked "What bird is this?", while exposing each flashcard. Token reinforcement was now provided for each correct response. Following the session, the subject was then allowed to exchange all tokens earned for the back-up reinforcers. The total session time, including post-test, was recorded. Additional information collected was the percentage of correct responses during post-tests, and the number of trials or sessions to mastery of each group. The criterion for mastery was 100% correct on two successive post-tests, and when the subject produced the appropriate name for each bird-picture in Group A for two successive post-tests, instruction was provided for the pictures in Group B until all names were correctly learned. Thus, the names of the birds were learned in groups of 5, and instruction continued to be provided on a group until all 5 names were correctly stated in the post-test.

### Retention

When the subjects had mastered all 3 groups of cards, a post-test was administered after an interval of three months. The stimuli for this retention post-test consisted of 18 picture flashcards (i.e., the 3 groups of 5 cards each plus the 3 additional cards that the subjects knew prior to instruction). These cards were included to provide at least a small amount of stimuli to which the children should respond correctly. Although the length of

the time lapse was not optimal, it was unavoidable as not all subjects were available during summer vacation.



## Chapter 3

### RESULTS

The total number of sessions required for each child to master the three groups of picture-flashcards is shown in Figure 1. The performances on Group A were almost perfectly correlated with IQ score; however, the trends evidenced for Groups B and C were inconsistent with the predicted relationship. It is interesting to note that there were two distinct patterns of learning demonstrated by the children in the number of sessions to acquisition of each group. The pattern illustrated by  $S_1$ ,  $S_2$ , and  $S_4$  would seemingly suggest that Group B contained more difficult materials than the other two groups. In contrast, the pattern illustrated by  $S_3$  and  $S_5$  suggests a learning to learn phenomenon.

Figure 2 demonstrates the percentage of correct responses achieved during session post-tests. This graph reveals some rather detailed information concerning the learning pattern displayed by each child. Although performances on the first set of cards had a tendency to substantiate the effect of IQ level on rate of learning, the subsequent performances again confused the directness of the relationship. Some similarities in the learning patterns between the children do exist. For instance, within each individual's performance, some groups of cards were learned

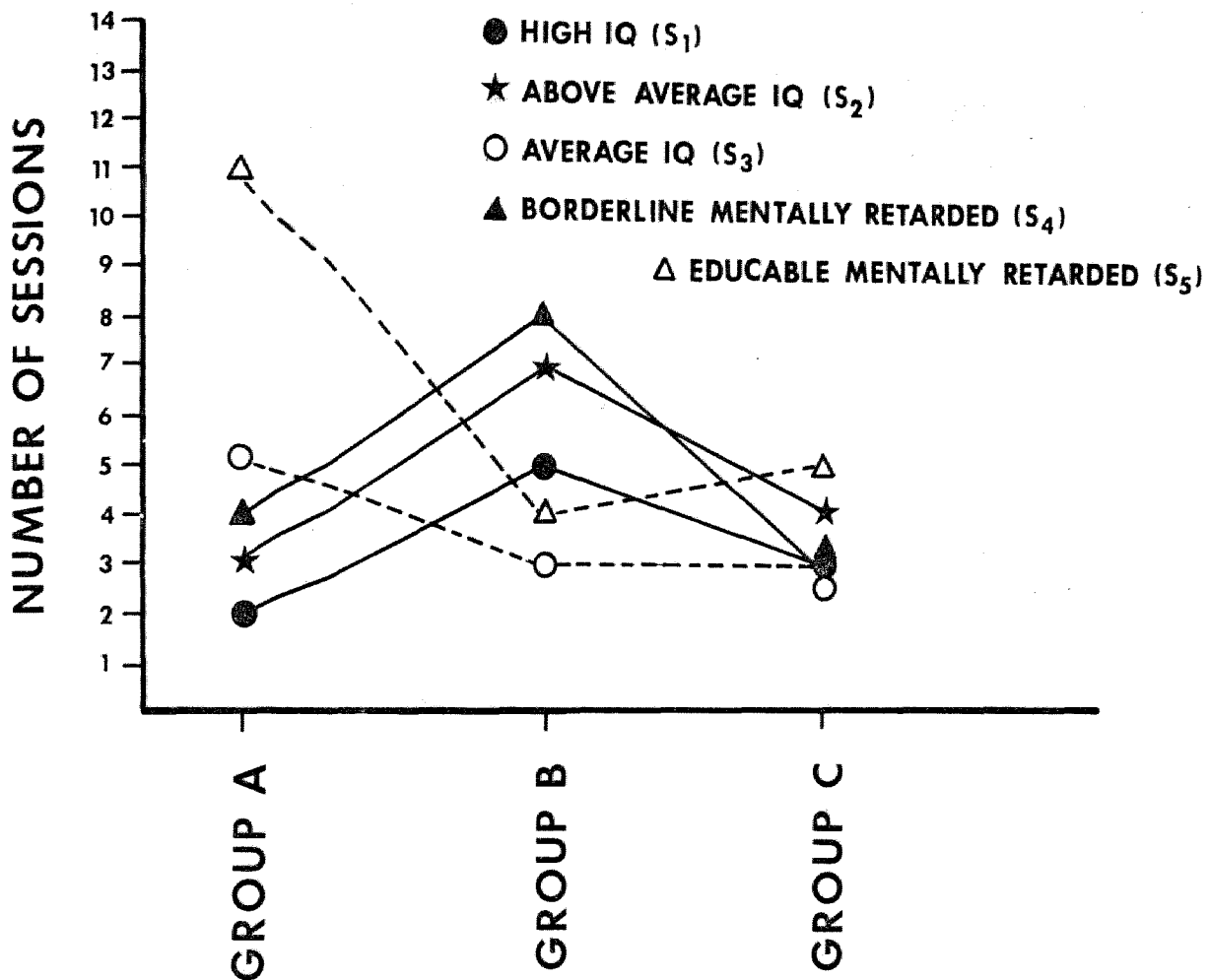


Fig. 1. Total number of sessions required for mastery of each group of picture-flashcards.

PERCENT CORRECT DURING POST-TESTS

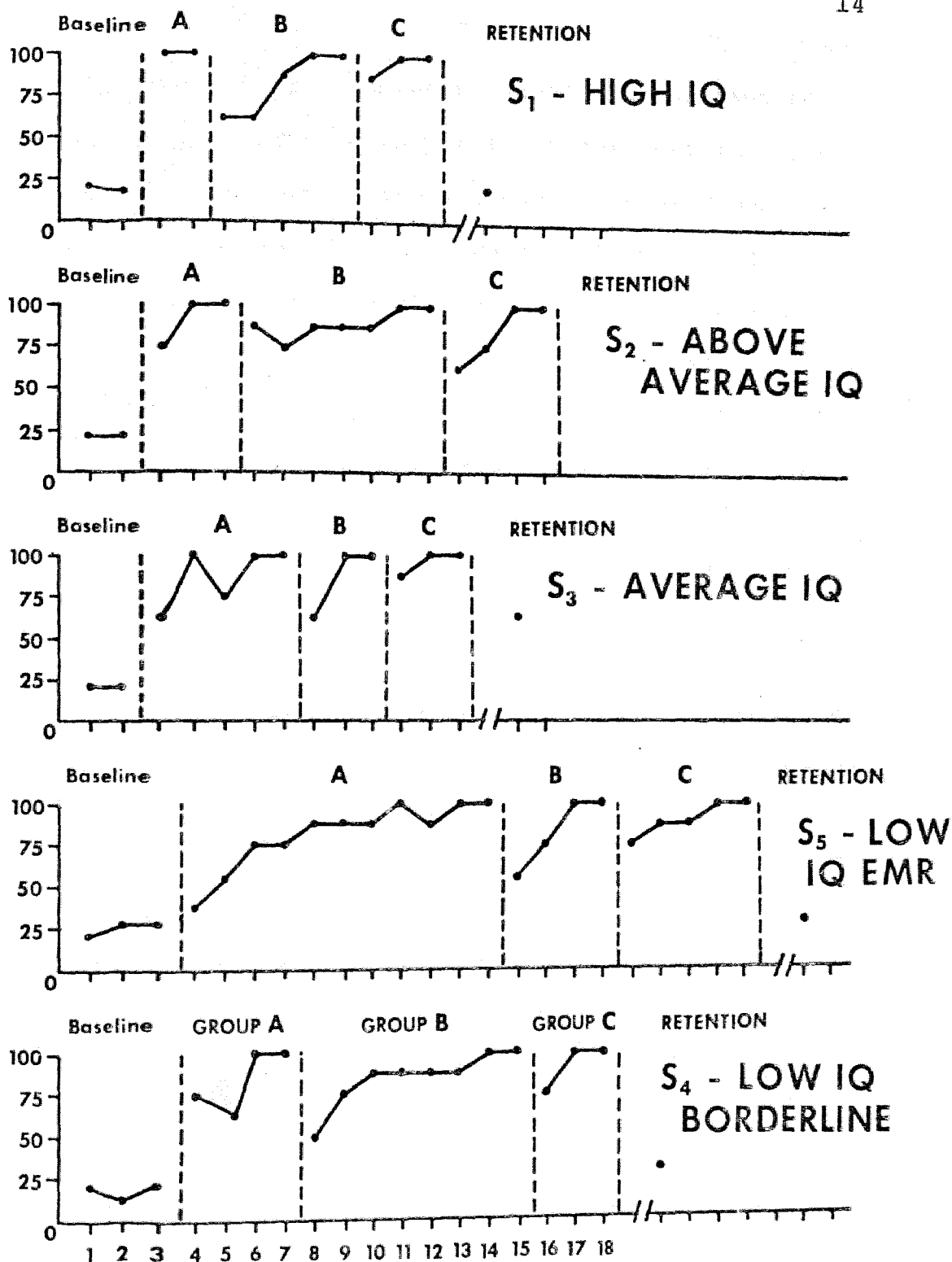


Fig. 2. Percentage of correct responses achieved during post-tests.

more quickly than others. However, these similarities in rate of learning occurred erratically rather than in a predictable fashion concerning specific subjects or groups of cards. The percentage of flashcards correctly labeled during the retention test is also presented in Figure 2. The amount of learning that was retained was especially low for the high and low IQ children. They responded correctly only to those picture-flashcards that they knew prior to instruction (as indicated by the pre-test), and remembered none of the names of the birds that they had mastered during instruction. Subject 2 was not available for the retention test because the family relocated in another town.

Figure 3 reveals a characteristic trend in performances with respect to the total session times for all of the children. Although the session times were not equivalent, they were typically longer when each group of cards was initially introduced. The amount of time spent per session then diminished as the children gained familiarity with the responses. The final session times were reasonably stable and consistent among all of the children.

Generally speaking, one would predict that more intelligent children would learn more rapidly and remember more information than less intelligent children. In order to determine if this prediction was consistent with the results from the present study, a comparison was made among the performances of all of the subjects. The children were

TIME IN MINUTES PER LEARNING SESSION

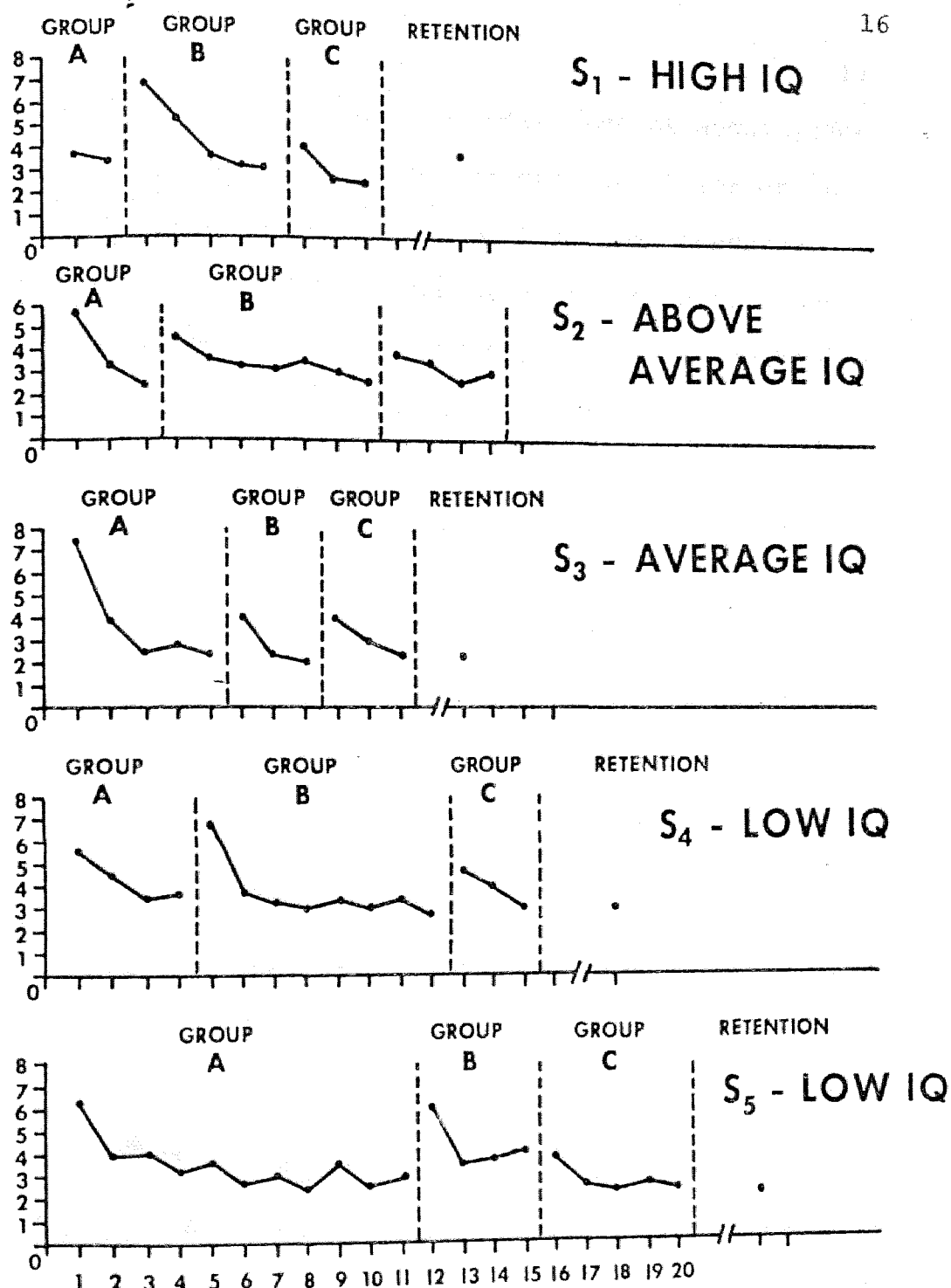


Fig. 3. Total number of minutes required per learning session (i.e. both instructional period and post-test).

ranked according to IQ score, and their rate of acquisition and retention was compared with that of each of the other subjects by a simple greater-than or less-than measure. The data from this comparison supported the prediction on 73% of the occasions and contradictory results were obtained on the remaining 27%. However, the singularly low retention measure for subject 1 accounted for a large percentage of those unpredicted outcomes. Thus, the outcome of this study indicated that IQ level was positively correlated with rate of learning of a simple learning task.

Although the response definition was unambiguous, inter-observer reliability was recorded virtually every session for the total session time and for the percentage of correct responses during post-tests. The reliability coefficients were 99.8% agreement with respect to the correctness of the response and 78% agreement with respect to the length of the session. This larger discrepancy can be attributed to the fact that the experimenter was using a stopwatch and the observer was timing the length of the session with a regular watch. In order to constitute an agreement, the session times needed to agree within five seconds, and the watch was obviously less precise than a stopwatch.

## Chapter 4

### DISCUSSION

There was no consistent relationship between the IQ scores and the performance measures taken in this study. Several possible explanations can be provided to account for such an outcome. One could argue that the relationship between IQ and rate of learning was present, but certain procedural shortcomings masked a strong effect. For instance, the comparative effectiveness of both token and the back-up reinforcement was not assessed; therefore differential motivational factors may have altered any predictable outcomes. A second procedural criticism is that the subjects were not responding in a free responding fashion. Undoubtedly there was some degree of experimenter control in the pacing of responses within each session, as well as there being a fixed number of responses available per session. A further methodological criticism regards the limitations imposed by such a small sample size. However, since most researchers in this area place the genetic contribution to IQ at 50% or higher, one might expect to see strong evidence of its effect, even with groups of one subject each.

The between-subject comparison of performance suggested a positive relationship between IQ level and rate of acquisition and retention. However, the exact nature and extent of this relationship can only be speculated. It is

certainly possible that the contribution of intelligence toward learning may show a more obvious effect with tasks of higher complexity. If, however, complex tasks are merely the accumulation of a series of simple tasks that build upon one another, then evidence of the proposed relationship should be reflected in the learning of simple tasks.

It is also possible that the relationship between IQ and rate and retention of learning is not critical to the one that presumably exists between IQ scores and school performance. Future research might be directed to determine what other aspects of learning and/or school performance distinguish the high IQ child from the low IQ child. For instance, one might look at finer measures of the rate of acquisition than simply the number of trials. This would necessitate utilizing a free operant design in which the subject had total control over how much material he covered during a session, and how much total time was spent per session in relation to the total number of responses mastered. This type of information might provide some illuminating differences between children of various IQ levels. However, in returning to the present data, it should be noted that during the more stable sessions (toward the end of each group), the within session times for all of the subjects were essentially equivalent. To what degree this was indirectly controlled by the experimenter can only be speculated.



In conclusion, some evidence for a positive relationship between IQ scores and performance emerged in this study. However, the results were confusing and certainly suggest further research. Two obvious changes include the use of a larger sample size and a free operant paradigm during the instructional phases of the study. Although many professionals suggest that the IQ test is a useful instrument, the relationship between IQ and learning is not as straightforward as might be assumed and caution should be used when placing students in special education programs primarily on the basis of IQ level.

## REFERENCES

- American heritage dictionary of the English language, ed. William Morris. New York: American Heritage Publishing Co., Inc., and Houghton Mifflin Co., 1973.
- Ayllon, T., & Kelly, K. Effects of reinforcement on standardized test performance. Journal of Applied Behavior Analysis, 1972, 5, 477-484.
- Brown, R., & Herrnstein, R. J. Psychology. Houston: Little, Brown and Co., 1975.
- Cobb, J. A. The relationship of discrete classroom behaviors to fourth grade achievement. Journal of Educational Psychology, 1972, 63(1), 74-80.
- Kamin, L. J. The science and politics of IQ. Maryland: Lawrence Earlbaum Associates, Inc., 1974.
- Kolstoe, R. H. Use of test results. Childhood Education, 1967, 44, 165-167.
- Lazerson, A. (Ed.). Psychology today: an introduction. New York: CRM/Random House, 1975.
- O'Connor, J. J., & Weiss, F. L. A brief discussion of the efficacy of raising standardized test scores by contingent reinforcement. Journal of Applied Behavior Analysis, 1974, 7, 351-352.
- Skinner, B. F. Science and human behavior. New York: The Free Press, 1953.
- Skinner, B. F. Technology of teaching. New York: Appleton-Century-Crofts, 1968.
- Staats, A. W. Child learning, intelligence, and personality. New York: Harper & Row Publishers, 1971.
- Zacharis, J. The trouble with IQ tests. National Elementary Principal, March/April, 1975, 23-29.